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ABSTRACT

This paper discusses the types of computer software that are most effective in a classroom. Detailed descriptions are given of: (1) drill and practice programs; (2) tutorials; (3) simulations; and (4) games and problem-solving software. The effectiveness of each is discussed as well as the characteristics of a good program of its genre. An example of how each program operates is given and the academic benefits are considered. The principles and examples of these programs offer guidelines for teachers in selecting good educational software for the classroom. (JD)

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SOFTWARE IN THE CLASSROOM: THE TEACHER AS JUDGE

by

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Introduction

Many teachers who have been promised - or threatened with - a microcomputer for their classroom find their excitement tinged with a bit of apprehension. Eagerness to see what this machine will do often co-exists with reluctance to disturb a well-established and effective classroom routine. Such hesitancy may be the mark of caution born of experience. It is the prudent teacher who seeks evidence of the value of a new technique before plunging into it.

What can a microcomputer do in the classroom? Can it really be an effective instructional tool? How do I know whether the software will help? Will it improve my lessons? These and other questions raised by the discriminating teacher demand consideration. Various answers have been given to such questions, all of which have educational implications. Some answers are debatable and all are incomplete. There is, however, one incontrovertible response: for a computer to achieve worthwhile things in the classroom, it should be in the hands of a competent teacher. The possibilities then become myriad, if not limitless.

The very diversity of opportunities, however, presents a danger. If it is true, as has been alleged, that a thing which can be done will be done, then a corollary to this proposition would hold that any computer programs that can be used will be used. This would be unfortunate, if not disastrous; a discerning teacher can easily recognize that many pre-programmed packages do

not fit his or her classroom needs.

Technological improvements notwithstanding, it is the teacher who must continue to decide what materials, methods, and sequence of instruction will best facilitate learning for a specific group of students. But technology does create the legitimate demand for teachers to become acquainted with the types of computer programs available and be prepared to judiciously evaluate their classroom worth. Our goal here is to attempt to facilitate this task by considering the chief instructional modes appropriate to computer use, setting standards for each, and providing examples.

Diversity of Computer Use

Although there are many instructional tasks which a computer cannot perform or can imitate only clumsily, others are quite suited to the computer's capabilities. Drill and practice, tutorials, simulations, games and problem-solving fall into this latter category. A detailed look at each will indicate the possibilities.

Drill and Practice

Many computer programs are referred to as drill and practice programs. Although the word "drill" tends to call forth the conditioned response "and practice", the terms have distinct meanings. Drill refers to the repeating of facts, in written or oral form, for the purpose of increasing the speed and accuracy of recall. Teachers spend time drilling addition and subtraction facts, drilling the multiplication tables, and drilling correct spelling of words.

Practice, on the other hand, is used to reinforce some procedure which has already been learned. Students need to practice multiplication of two-digit numbers, practice writing coherent paragraphs, and practice playing the piano.

Keeping this distinction in mind, let's examine the issues involved in drill and practice via computer.

Characteristics of Good Drill and Practice Programs

Since drill and practice do not involve the teaching of any new concepts or facts, computerized programs are relatively easy to write. This explains the proliferation of such programs in the software market. Unfortunately, the quality does not match the quantity . Many of the endeavors are technically sound but pedagogically deficient. A good drill and practice program should incorporate the following features:

1. The user should, if possible, have a choice of level of difficulty.

Some programs are designed to provide drill or practice on just one level of a topic. Lessons can be designed, however, to be multi-purpose, serving a wide range of abilities. Such programs allow a student to choose more difficult lessons as he or she advances. For example, an addition program could allow the choice of how many digits are to be used; a music drill could permit the user to choose the key or the signature. In most programs, the speed at which the questions are posed should also be under the control of the user.

2. The program should correct wrong answers.

Merely being told that an answer is wrong is not sufficient. However, it is good to allow the student more than one try before giving the correct answer. For example, the response to the first incorrect answer might be "Sorry, wrong answer"; the second incorrect attempt might call forth a clue and the third error be followed by the correct answer. An explanation of how the correct answer was obtained would be an additional helpful feature.

3. Right answers should be reinforced.

The computer can provide reinforcement in various ways. A simple "Good job" is a straightforward, welcome bit of praise. Graphics can be used in many clever ways as reinforcement; in many cases the picture can be made to fit the topic. Sound effects can also be used; while these appeal to many youngsters, they can be distracting in a classroom and annoying after extended repetition.

4. Graphics should be used appropriately within the lesson.

At times, graphics can be an integral part of a lesson, illustrating topics such as fractions or key signatures in music. At other times, the use of graphics may be pedagogically non-essential, but valuable as enhancement, serving to emphasize a point or simply to foster motivation. A program without graphics lacks one of the special features which a computer can bring to a lesson.

5. Score-keeping should be provided.

The computer is an excellent scorekeeper and can easily keep track of the type and number of exercises worked correctly. This information provides both the student and the teacher with knowledge of how well the topic has been mastered and whether further drill or practice is necessary.

Example: Drill

For the sake of example let's examine a simple program written by a student in an introductory "Computers in Education" course. The intent of the program is to give practice in forming the past tense of verbs. A sentence is displayed with a blank for the verb, e.g.: Grandmother _____ me to knit. Underneath the sentence, the present tense of the verb is given (in this example, the verb is "teach".) The student is directed to type in the past tense of the verb. If the correct answer is given, the student is rewarded with one of three graphic designs; if an incorrect answer is given, the correct response is displayed. Although this particular program does not keep score, such a feature could easily be added. This program is simple in structure yet pedagogically relevant.

Example: Practice

Practicing a procedure via computer is more difficult than drilling a fact. Nonetheless, there are some effective practice programs.

A delightful practice in locating points on a coordinate grid is furnished in a program called "HURKLE" produced by the Minnesota Educational Computing Consortium. In this program,

HURKLE hides on a coordinate grid and the user must find him. In accord with the principles of good drill and practice programs, the user is given a choice of whether to let the HURKLE hide on a one-or two-dimensional grid. A wrong guess as to HURKLE'S location is followed by a clue telling in which direction to look; a record is kept of how many tries it takes to discover the hiding place. The appearance of HURKLE, with accompanying sound, is reinforcing for any age group.

Benefits of Drill and Practice

The remark is sometimes made that a program is "only good for drill." This is analogous to saying that an exercise bike is only good for exercising. Should a thing be criticized for doing that which it was intended to do? The important question is "Did the program discharge its intended function?".

If a teacher has diagnosed that a child or an entire class needs drill or practice on a given topic, then the microcomputer may very well be able to take over this routine function. If the lesson adheres to the principles stated above, the computer may be able to perform the task more efficiently, more systematically, with greater patience, and with more motivational aids than the teacher could alone.

TUTORIALS

While there is debate over the need for drill and practice programs, no such argument exists for tutorials. Much of education is concerned with the teaching of new facts, rules, principles, and concepts. Thus, unlike its humble cousin, the

drill and practice program, the tutorial does not need to justify its existence.

The task of leading a student to master a new concept is, of course, far more difficult than that of drilling something already learned. This difficulty persists, regardless of the instrument of instruction. The following principles apply whether the lesson is being conducted via computer or via teacher cum text, workbooks, and chalkboard. Their importance, however, is augmented for computer-based lessons where all possibilities must be foreseen and built into the lesson before it reaches the classroom.

CHARACTERISTICS OF GOOD TUTORIALS

1. The purpose of the lesson must be clear.

A direct statement of purpose or objectives helps to focus the learner's attention on the main issues of a lesson. In the case of computer software, such a statement of purpose also helps the teacher to determine the appropriateness of the program.

2. Necessary prerequisites should be stated.

If prior knowledge or skills are assumed, this should be made clear at the onset. This is especially important for computer tutorials. A teacher, if very flexible, may be able to change course in midstream, abandon a lesson plan, and adapt to the confusion indicated by students. Not so for computers. Although branching is possible within computer lessons and review may be included when wrong answers are given, this adaptation is limited and cannot cover all possible sources of confusion. Thus it is

important for the user to know from the onset what prior knowledge he or she should possess before beginning the lesson.

3. All aspects of the lesson should be appropriate for the given audience.

Vocabulary is of primary importance here. A lesson can be pedagogically sound in every other aspect of development, but will lose its effectiveness if the vocabulary is not understood by the intended audience. On the other side of the coin, an elementary school vocabulary, used in a program intended for adult audiences, can be equally jarring. Graphics and reinforcements in the program should also be age-appropriate.

4. In teaching a rule, a principle, or a concept, the approach may be either deductive or inductive. In either case, appropriate sequencing of steps must be followed.

Deductive learning begins with a general rule, principle, or definition, and then proceeds to the particular. Thus, a student might be given the rule for forming plurals of nouns, and then asked to apply it to particular cases.

Inductive learning, on the other hand, takes place when the learner is given many examples and then asked to formulate the general rule or concept. For example, after seeing many examples of plural nouns, the students would be expected to give the general rule for forming plurals.

Use of either the deductive or inductive method can be an effective teaching strategy. Whichever method is used, computer

tutorials should proceed in small, logical steps. Lessons which lack a consistent approach can be confusing to the student.

5. Practice, with branching to appropriate sections, should be provided.

Since it is well established that we learn best by doing, the learner should be actively involved in the lesson. Opportunity should be provided for the learner to apply what has been taught and to receive feedback on his or her attempts at various stages throughout the lesson. Since some students learn more quickly than others those who have mastered the material should be able to advance to another section, whereas review or further instruction should be provided for those needing additional help.

6. A self-test should be included.

Whereas practice is included as an integral part of the learning process itself, self-tests at the conclusions of a lesson ascertain whether the desired learning has taken place. Depending on the score which the student obtains, the lesson should either be repeated (a far easier task for a disk than for a teacher), additional practice should be assigned and monitored (a cinch for the computer) or the student should move on to new material.

Example: Tutorial

Good tutorials are more difficult to write, and therefore more difficult to find, than good drill and practice programs. It is not easy to incorporate all desirable features into a self-sufficient lesson. Some attempts, however, have come close.

The "Comprehension Power Program" (Milliken) teaches 25

comprehension skills needed for intelligent reading. The thrust of the program is to have students acquire these skills through directed reading experiences. The teacher is asked to determine, with help from guidelines provided in a teacher's manual, the entry level of each student. Students can control the rate of presentation and can choose to re-read a passage. Reading selections are based on a wide variety of topics (clowns, peer pressure, police, buying on credit), which should appeal to a diversified user group.

The authors of the program clearly state that the lessons are inductive in nature. Students are helped to gain insight into the comprehension process through carefully planned experiences, rather than through having skills defined and drilled. The questions asked of the reader after each selection are a critical factor in this process.

Frequent tests provide feedback regarding the student's progress in designated skills. A management system makes it easy for the teacher to keep records of students' progress and to assign appropriate materials for each lesson.

Benefits of Tutorial Programs

Although the relative lack of fl xibility in a computer tutorial has its drawbacks, it also has certain advantages. A student may tire of a lesson, may look bored or even hostile, but, unlike most humans, the computer cannot become riled up or upset. It retains its composure, proceeds with its established sequence

of instructions, and repeats its lessons with all their original lustre.

SIMULATIONS

In providing simulations, the microcomputer lesson comes into its own. A good workbook can provide drill and practice exercises; a skilled teacher can gracefully lead a class to the learning of new concepts and ideas. A computer lesson may be of great assistance in either of these tasks. But in simulating an event which cannot be experienced directly, the microcomputer creates a unique learning opportunity.

Characteristics of Good Simulation Programs

Since a simulation is an imitation, it necessarily lacks some of the attributes of the original. Pedagogically, the important thing is that it not lack qualities which would make the outcome of the simulation substantially different from the real outcome.

A good simulation program will possess most of the characteristics prescribed for drill and practice and tutorial programs. In addition it will adhere to the following:

1. The user should be able to manipulate the variables easily.

Since the essence of a simulation is to show "what happens when...", it is important that the user be able to determine the conditions. Without this, the user is relegated to a passive role and has no opportunity to test out his or her own hypotheses.

2. The outcome of the manipulation of variables must be shown or described.

Without sufficiently detailed knowledge concerning the results of variable manipulations, the user cannot know the correctness of his or her choices nor what changes to make on the next attempt.

3. The essential relationships between variables must be preserved.

This condition is the sine qua non of simulations. If variables are not portrayed in the same relationships as they would be found in the actual situation, then the simulation could be misleading.

Example: Simulations

A painless lesson in economics can be experienced through the "Lemonade Stand" program popularized by Apple Computer, Inc. In this program the user is given the chance to become an entrepeneur, managing his or her own lemonade stand. As manager, the user may choose how many glasses to make each day, how much to charge for each glass, and how many advertising signs to make. Weather conditions and the activity of his competitors, however, are beyond his control. Thus, the control granted to the user is realistic.

After each day's activities, a financial report is shown, detailing the day's transactions. The user is never directly

informed of the effects of the advertising signs, but is free to experiment with the number to be used on subsequent days. In general, sales are related to the price of the lemonade and the number of signs, thus maintaining a realistic relationship among these factors.

Benefits of Simulations

Due to the accuracy required and the relationships to be considered, simulated lessons can be quite difficult to produce. They do, however, provide an educational opportunity which would otherwise be lacking. Time and space can be compressed in a way not possible in reality. Events which it would be impossible to experience (such as space travel) or dangerous (such as random combining of chemical elements) or exceedingly expensive or time-consuming (such as managing a business) may be portrayed and manipulated.

EDUCATIONAL GAMES AND PROBLEM-SOLVING

Some care is necessary in speaking of educational computer games. To many children this conjures up images only of" PAC-MAN" and various forms of space invaders. A far broader concept of "game" is intended here. An activity with rules, structure, goals, and clear criteria for "winning" will be considered a "game". Fashioning a winning, or successful, strategy for a game involves problem-solving skills. Most games also include some form of competition.

These characteristic can effectively be incorporated into computerized learning activities. The computer is designed to

handle structure and rules; it can specify goals and keep track of whether or not criteria are met. The computer can also easily handle competition: it can allow the user to compete with him-or herself, aiming for a better score each time (the best form of competition); it can also act as competitor, or can keep score as individuals vie with each other. Although competition is built into most games, it is not absolutely necessary. Games can also be built upon cooperation, with players working together to accomplish a goal. Educationally, this has much to be said for it. Competition is so common in school that experience in mutual endeavors is needed to give students a taste of another aspect of life and work.

Characteristics of Good Educational Games

The computer has several capabilities, including score-keeping and graphics, which can enhance game-playing. When these are combined with solid pedagogy, the result can be a very effective learning opportunity. For this to occur, the following conditions should be met:

1. The educational content of the game must be sound. Although a game cannot incorporate all aspects of an educational topic, it must treat accurately those which it does use. The topic should have some substance to it: trivial content leads to only trivial learning.

2. The computer must judge all user imput in an accurate manner.

Sound pedagogy demands that programs respond sensibly to a wide variety of user inputs. Accuracy must not be sacrificed for the sake of ease. A program which does not recognize that 4/8 is equivalent to 1/2 is not pedagogically sound. Such programs have no place in the classroom.

3. The game should present a real challenge.

Just as a problem is not a problem if the answer is obvious, so, too, a game is not really a game if there is no challenge. The tasks presented, however, should be ones which the user is capable of mastering. To meet this requirement, the creator of the program must understand the normal capabilities of the age group for which the game is intended.

4. Rules must be clearly stated and followed.

Some games allow second tries, others do not. Some allow a margin of error in the reply; others require absolute exactitude. It is important (especially if two players are competing) that these particulars be made explicit to users.

5. The computer should exercise its score-keeping powers.

The outcome of a game usually depends on the final scores; hence these should be kept by the computer and displayed at the appropriate times. The computer could also keep records from one game to another, so that comparisons may be made.

6. Games should be enhanced through the computer's unique capabilities.

One of the advantages which computer games have over others

is the possibility of immediate feedback. Clues can be provided either upon request or following inefficient or incorrect moves. (This feature is usually incorporated into "adventure" games.) Graphics and sound can also add interest and pizazz to games.

Example: Educational Games

A disk from the Learning Company called "Gertrude's Secrets" contains games in the form of puzzles. The program is designed for children and relies almost exclusively on graphics for communication. Solving the puzzles involves recognition of shapes, colors, and above all, relationships and patterns. Each time a puzzle is solved, the player is rewarded with a prize stored in the "treasure room."

However, in order to work a puzzle, the user must find the way to the appropriate game room. Hence, the entire program becomes an exercise in problem-solving. Part of playing the game becomes finding the game. Discovering the proper sequence of steps is not trivial; young children would need guidance on their first tries.

Benefits of Educational Computer Games

The inherent attraction of games makes them an enticing vehicle for educational content. Many drill and practice lessons, as well as some tutorials, could be embedded in a game context

with no loss of pedagogical soundness. The resulting motivational appeal would augment the value of the lesson.

Games also present an ideal opportunity for the development of problem-solving strategies. The user has a clearly defined goal and must plan how to accomplish it. A teacher can and should exploit to the fullest the learning potential of such situations.

Conclusion

The principles and examples cited above illustrate some of the possible ways in which teachers can use microcomputers to supplement a lesson. Each is dependent upon selection of quality software. Pertinent questions must be raised:

Is this lesson pedagogically sound?

Does it meet the need of my pupils?

Will my lesson be enhanced if I use this software?

Only the teacher can judge whether the required affirmative response can rightfully be given to these questions.

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